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Sea Grant Annual Report 1972

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SEA GRANT ANNUAL REPORT 1972

A REPORT ON THE VIRGINIA INSTITUTE OF MARINE SCIENCE
SEA GRANT PROGRAM FOR JANUARY 1 - DECEMBER 31, 1972



VIRGINIA INSTITUTE OF MARINE SCIENCE
Gloucester Point, Virginia 23062

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A Report on the Virginia Institute of Marine Science
Sea Grant Program for January 1 -December 31, 1972

Special Report No. 43
in Applied Marine Science and Ocean Engineering

Compiled and Edited by
W. David Garten, Fred C. Biggs and John L. Wood, Ph.D.



Sea Grant Program

VIRGINIA INSTITUTE OF MARINE SCIENCE
Gloucester Point, Virginia 23062

Dr. William J. Hargis, Jr., Director



Table of Contents

Advisory Services	
Marine Extension Activities	6
Advisory Services	
Publications; Information and Education	8
Study of Ocean Wave Refraction for Virginia's Coastline	11
Inventory of Mineral Resources off Chesapeake Bay	14
Improvement of Fisheries for Molluscs	16
Improvement of Fisheries for Crustaceans	18
Management of Larvae—Supply of Algal Food	24
Sea Grant Publications	26
Sea Grant Activity Budget—1972	28



In early years the Sea Grant-sponsored program at VIMS was directed toward improved understanding of the resources and environments of the near shore coastal and estuarine areas of the mid-Atlantic (Virginian Sea) region. Recently, however, it has become apparent that commercial and recreational attention is being focused upon the outer continental shelf. A surge of proposals for offshore port and power plant developments, oil exploration and exploitation, more vigorous fisheries management, solid and liquid waste disposal, and for many other purposes has given rise to renewed interest in these areas. A paucity of knowledge, so necessary to rational planning and management as well as effective engineering of projects and a meaningful evaluation of their environmental impacts, became apparent.

We do not know how quickly (or whether) oil wells, oil ports, offshore power plants and bulk-materials terminals will develop off the shores of Delmarva or in upstream regions, but the pressures and potentials are there. The pace of mining developments is also uncertain, but the need to know is imminent.

Deeper channels and destruction of shorelines are deep-seated problems already facing coastal zone managers, and utilization of shelf-related fishery resources strains knowledge and technology. Information relevant to these problems should have been gathered, synthesized and analyzed long ago. Of course, some was, but to speed reduction of ignorance and increase manipulation abilities we decided

to study several aspects of shelf circulation and of non-renewable resources of the southern Virginian Sea.

This year Sea Grant support helped Virginia's oceanographers begin a series of projects along the shelf, as noted in the pages of this report. The study of ocean wave refractions and the accompanying effort to understand and plot areas of confused or calm sea state are an excellent beginning to the accumulation of a needed information base that will help determine what can be developed—when and where—along the shelf. Continuation of this work may also provide data of importance to those who will decide upon the propriety of offshore projects, considering their potential threats to the coastal environment as well as the expected profits to the coastal, indeed the national, society.

The survey of mineral resources off Chesapeake Bay suggests sedimentary materials of the shelf floor that are favorable for mining. While emphasis has historically been upon harvest of biological resources from the sea, we now look to these physical resources as having significant economic potential, but not without problems—technological, legal, political and environmental—in harvesting. We have a larger "leg-up" on problems of the continental shelf.

Concurrent progress was made on projects relating to mariculture and controlled production of oysters, hard clams and bay scallops. Efforts to bring shedding—an important stage in development of the valuable softshell stage of the blue crab and of the rock crab—

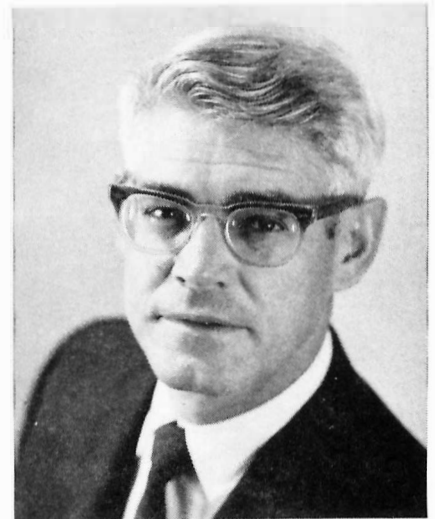
made headway. New strains of oysters were spawned and tested.

Of significance have been the tangible contributions of the Sea Grant-VIMS Advisory Services to managers and users of estuarine environments and resources. We are confident that these have resulted from direct contacts, publications and other advisory services, and that the Sea Grant Program has, with VIMS, received justification of its support.

We look forward to another year of progress.



Dr. William J. Hargis, Jr.



Dr. Hargis, director of the Virginia Institute of Marine Science since 1959, is principal investigator and overall program manager of VIMS' Sea Grant Program.

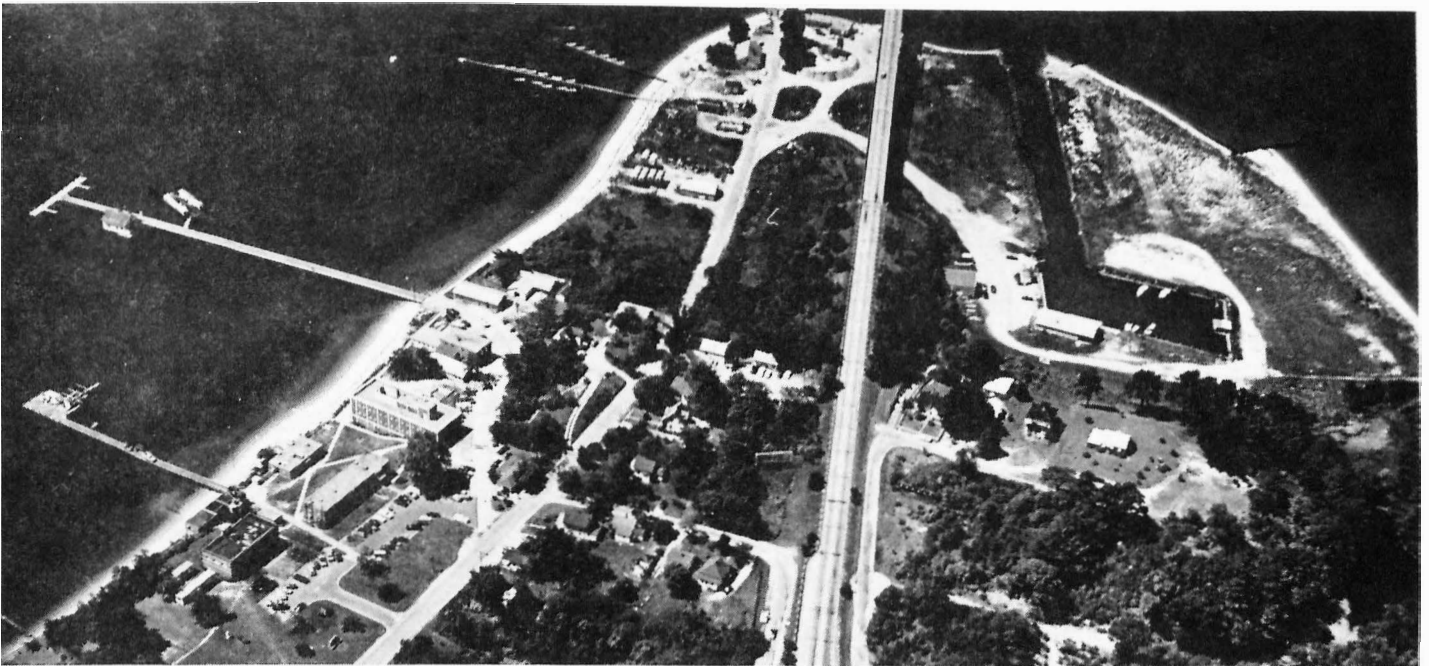
The Virginia Institute of Marine Science (VIMS) is situated on deep water near the mouth of the York River. It is 33 miles from the Atlantic and 35 miles downriver from fresh water. Its research area encompasses the transition between land and open ocean and it includes the lower Chesapeake Bay (largest and most important estuarine system in the United States), tributaries of the Bay, and the coastal and shelf waters of the Virginian Sea. A variety of environments are accessible to scientists from the main laboratory at Gloucester Point and the Eastern Shore branch at Wachapreague.

From its earliest days, the Institute, which is the principal marine program of the Commonwealth and its coastal zone laboratory, has been involved in resource research, advisory services and education. With the advent of P.L. 89-688, the VIMS administration felt that there was an excellent opportunity to accomplish tasks long recognized, but for which there had been insufficient funds. Motivation for seeking Sea Grant support arose from needs of the Institute to strengthen its ability to carry out those of its functions which involve goals common to Sea Grant and local needs.

The Institute's Sea Grant Coherent Projects, begun in December 1968, have had as

long-term goals:

- Understand current uses of estuarine resources and their interactions.
- Evaluate effects of human activities on the environments (habitats) of useful organisms.
- Develop improved methods of managing estuarine resources.
- Improve methods of rearing, processing and marketing commercially valuable species.
- Explore for new resources. Domesticated and improve, through selective breeding, useful wild stocks.
- Disseminate knowledge acquired.



Advisory Services

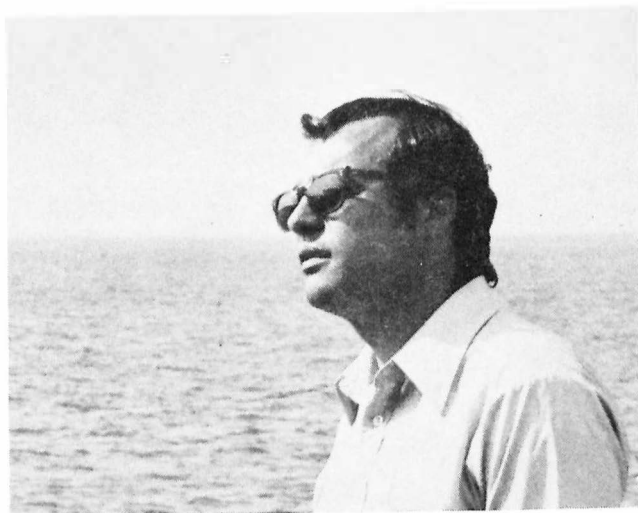
Marine Extension Activities

1972 was a year of progress for extension activities at VIMS. Significant changes were made in organization, and additions to the staff increased the stature, scope and efficiency of this portion of the Sea Grant Program.

Organizationally, extension activities were consolidated into a new Department of Advisory Services. A marine advisory specialist with training as a resource economist was hired to head this department, under the supervision of the Institute director. These actions recognized the importance of advisory services and enhanced the development of the extension program. The addition of this economist to the staff also increased the breadth of expertise readily available to

the marine constituencies served by VIMS. The scope was broadened even further by the addition of a specialist to help meet the needs for advisory services among recreational interests.

Program accomplishments during 1972 were varied and substantial. Numerous contacts were made with representatives of commercial and recreational fishing industries, federal and state agencies and others with marine-related interests. The diversity of these contacts represented an expanded clientele and a cross-section of levels of decision-making. As a result, verbal and written responses were made on a wide variety of subjects which were often followed by an advisory specialist's visit to help resource users make specific use of information.



Advisory specialists participated in efforts to demonstrate the commercial feasibility of shellfish culture processes developed under the Sea Grant research program at VIMS and to reduce losses to industry from the occurrence of "pink" oysters. A successful shellfish depuration workshop was held in cooperation with the Department of Applied Biology. This workshop attracted oyster growers, shellfish processors and representatives of State government.

Research activities by advisory specialists included a study of pink coloration in oysters and significant inputs into an indepth study of the commercial and recreational fisheries of the Eastern Shore of Virginia. Fishing gear and fishing techniques were also investigated.

Joint projects of VIMS with other groups also actively involved advisory specialists. One such project was to determine the optimum size at which cultch-free oyster spat reared in a hatchery can survive in a natural environment; another was to demonstrate the feasibility of new techniques (aggregate method) of field-rearing hard clams which were produced in a hatchery. Due to the long-term nature of these two projects the results have not been fully assessed.

Still another joint project was a massive effort to alleviate the disastrous effects of Tropical Storm Agnes. Activities included assembling crucial information regarding storm damages and disseminating it to appropriate state and federal agencies. Also, the coastal population was informed



of sources of financial aid and eligibility requirements of various sources. Assistance was rendered in monitoring oyster grounds to provide data on mortalities in specific areas due to the storm's effects. This sampling provided information which was needed by lending agencies to implement their loan programs. Due to special provisions of disaster loans which reduce the costs of capital needed to restore marine production, substantial benefits have accrued to the region.

Many more extension services were performed in 1972 by the staff of the Department of Advisory Services. For instance, numerous workshops, symposiums, and meetings involved advisory specialists as active participants. Also, as part of a process of continuous review, activities conducted in 1971 in regard to the "pink" oyster problem were evaluated and reported in 1972. This review indicated concrete results and a favorable relationship between benefits and costs.

Advisory Services

Publications; Information and Education

The primary goal of the publications unit of the Advisory Services Program is to disseminate understandable facts to the principal beneficiaries of the Sea Grant Program work. Emphasis during the report year was on the use of publications and news media to broadly disseminate Sea Grant information to marine users, sport fishing and commercial fishing industries and enterprises, government agencies, and others using or managing marine resources for profit or service.

Our approach was chiefly through two publications—the *Marine Resource Information Bulletin* and the *Marine Resources Advisory Series*. A broad range of subjects was covered in the *Bulletin*, whereas subjects requiring more detailed treatment were covered

in the *Advisory Series*. During the report year, 15 issues of the *Bulletin* were distributed. *Advisory Series Pamphlet No. 6*, "Shell Bags for Catching Oyster Spat", was printed and distributed in April.

During 1972 several strides toward improvement of activities were made. Greater diversity of information placed in the *Bulletin* was emphasized. Efforts were made to improve its appearance; cost and effort necessary to print and distribute the *Bulletin* were reduced by changing from the Xerox copy method to tabloid offset printing.

The tabloid rotary offset gave the equivalent of eight pages of 8½" by 11" space which minimized distributional handling problems, and allowed use of photographs to illustrate articles. The volume of subscribers can be increased with little change in handling efforts and with a decreasing cost-per-unit ratio.

In a search for economy, we reviewed the cost factors involved in mailing the *Bulletin* and changed from first class mail service to bulk rate, resulting in substantial postal savings.

A reader survey was mailed to *Bulletin* subscribers in November in an attempt to improve audience identification and feedback. A self-addressed return envelope was enclosed to encourage response, and of 2,329 surveys mailed, 967 responses were received, which represents over 41% of the circulation. This suggests an estimate of minimum readership, assuming respondents read more than the items detailed in responses. This seems a safe assumption.



Evaluation of the survey shed light on the categories of people reading the articles, their interests in the information, and in some cases, the uses to which information was put. We also learned more about what type of information appeals to editors of other periodicals and newsletters, which may be an excellent barometer of information applicable to the audiences we intend to reach.

During the report year, 373 requests for services and information were received. Most of the requests were from industry, government agencies and the news media. Correspondence suggested that people do read the publication, and a respectable number requested subscriptions to the *Bulletin* and *Advisory Series*. Many who contacted us mentioned specific stories in the publications and requested more information, back issues and other publications.

Information relating to use, development and replenishment of marine resources was mailed regularly to some 2,450 recipients in 36 states and 14 foreign countries. In addition, news releases were distributed to approximately 625 newspapers, technical periodicals, TV and radio stations

and interested agencies and individuals.

In order that information designed for special users reach the people it could best serve, the mailing list was divided into categories including News Release,

News Media, Sea Grant, MRI Bulletin, Virginia General Assembly, Wholesale Dealers in Fishery Products, State Agencies, Shellfish Shippers, Oyster Ground Leasers,



Boat Docks and Marinas, and Sport Fishing Facilities.

Since the publications unit functions within the framework of the VIMS Department of Information and Education, we were able to further add to our advisory program through public education channels such as educational television and films, educational periodicals, and exhibits and meetings, all designed to reach teachers, students and others in the

public education sector.

One information officer was assigned full-time to educational activities. During 1972 he helped prepare three educational television programs, three commercial television programs and one educational film on the blue crab. (This film, "Chesapeake Blues", produced by Cameo Camera Productions of Waldorf, Maryland, won a Golden Eagle Award of the Council on International Nontheatrical Events.)

Five exhibits were set up at public events and special conferences. Twenty-six speaker

programs for various citizen groups were presented during the year and over 4,000 students and teachers visited VIMS for special lectures, tours and collecting trips. In addition, a marine-resource-use short course was taught at three Virginia colleges during the summer.



Study of Ocean Wave Refraction for Virginia's Coastline

Ocean wave refraction plays a dominant role in controlling the distribution of wave energy along the Atlantic Coast. Knowledge of the specific refracted wave input at a site is critical to the successful implementation of shoreline defense programs and is necessary for a complete understanding of continental shelf sedimentation processes. As a research and service agency, VIMS applied for Sea Grant support to compute the refracted wave behavior for the Virginia continental shelf and shoreline.

During the first year of the program, wave refraction characteristics for the continental shelf and ocean shoreline of Virginia were computed. This marks the first time refraction processes have been computed for such a large area—20,000 square miles of continental shelf and 200 miles of shoreline. Considering 17 different wave parameters for 150 distinct wave conditions, this represents over one million useful pieces of data.

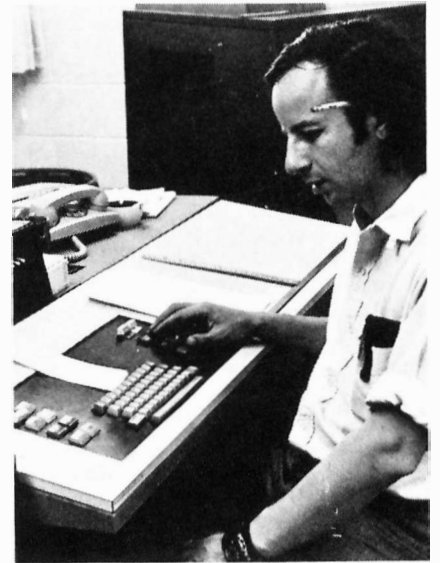
Agencies using this information will be VIMS, the Corps of Engineers, City of Virginia Beach, U.S. Fish and Wildlife Service, and other Federal and Commonwealth agencies and industries.

The purpose of the study is to supply VIMS (as a state agency with responsibility as advisor to the Commonwealth and other user agencies) with the information needed for enlightened management of shoreline resources. An important part of such information is the behavior of ocean waves on the continental shelf and adjacent shoreline.

A study by E. F. Thompson and D. Lee Harris, presented at the

Fourth Annual Offshore Technology Society at Houston in May 1972, depicted little correlation between ship wave observations made on the seaward edge of the New Jersey continental shelf within the same time interval as recordings of the same waves on a pier at Atlantic City. It further suggested that a knowledge of the refraction patterns of the waves as they move across the shelf was therefore absolutely necessary for an understanding of wave behavior on the shelf and along the adjacent shore.

The interrelationships between the water of the continental shelf and adjacent shoreline are most clearly shown through detailed analyses of waves as they travel over the shelf and impinge along the shoreline. Passing over the shelf they interact with the highly irregular shelf bathymetry consisting of



linear ridges and swales, relict drainage systems and shelf-edge canyons. This wave interaction with the shelf geomorphology results in dramatic changes along portions of the wave fronts in key wave parameters such as wave speed, approach angle, height, length, energy, power, bottom orbital velocity and longshore power gradient. These parameters may be affected as far as 60 miles from shore for waves with a period of 14 seconds along areas with a wide shelf, such as the mid-Atlantic Coast.

Technologically, acquisition of detailed wave information through direct measurement is nearly impossible. One alternative is to use the known depth information as input into a mathematical model which uses standard linear wave theory. Due to the advent of high-speed digital computers, such models have become increasingly common within the last few years.

Basically, the mathematical models move a single wave ray at a time shoreward across a grid of depths. Wave behavior is determined for a number of rays for each specific wave condition (i.e., wave period, height, direction and tide) and for a variety of wave conditions.

The Virginian Sea Wave Climate Model used by VIMS is an improvement over previous models. A report now in preparation will describe the model and its developments, emphasizing its advantages over other models. Future reports will present detailed results of studies utilizing the Virginian Sea Wave Climate Model and will apply the information to such questions as:

- Where are the locations on the continental shelf which experience large or confused seas due to wave refraction?
- What is the distribution of wave-induced orbital bottom currents on the continental shelf?
- What is the shoreline wave energy distribution?

A study such as this, in which over 200 miles of shoreline is treated as one unit, necessitated the solving of some special problems involving the accumulation of the large amount of depth information and the curvature of the earth. Most depth information was obtained directly from original U.S. Coast and Geodetic Survey sounding sheets and integrated by transferring all the depths using latitude and longitude onto a single acetate grid. Problems with distorted representations of the curved earth's surface on flat maps were worked out by constructing a Transverse Mercator Map Projection so that a great circle path taken by the ocean waves over the Virginia continental shelf can be represented with a minimum of distortion on a plane surface through the use of this properly constructed map projection.

One indirect spinoff of this study will be the most detailed compilation of the bathymetry yet attempted for

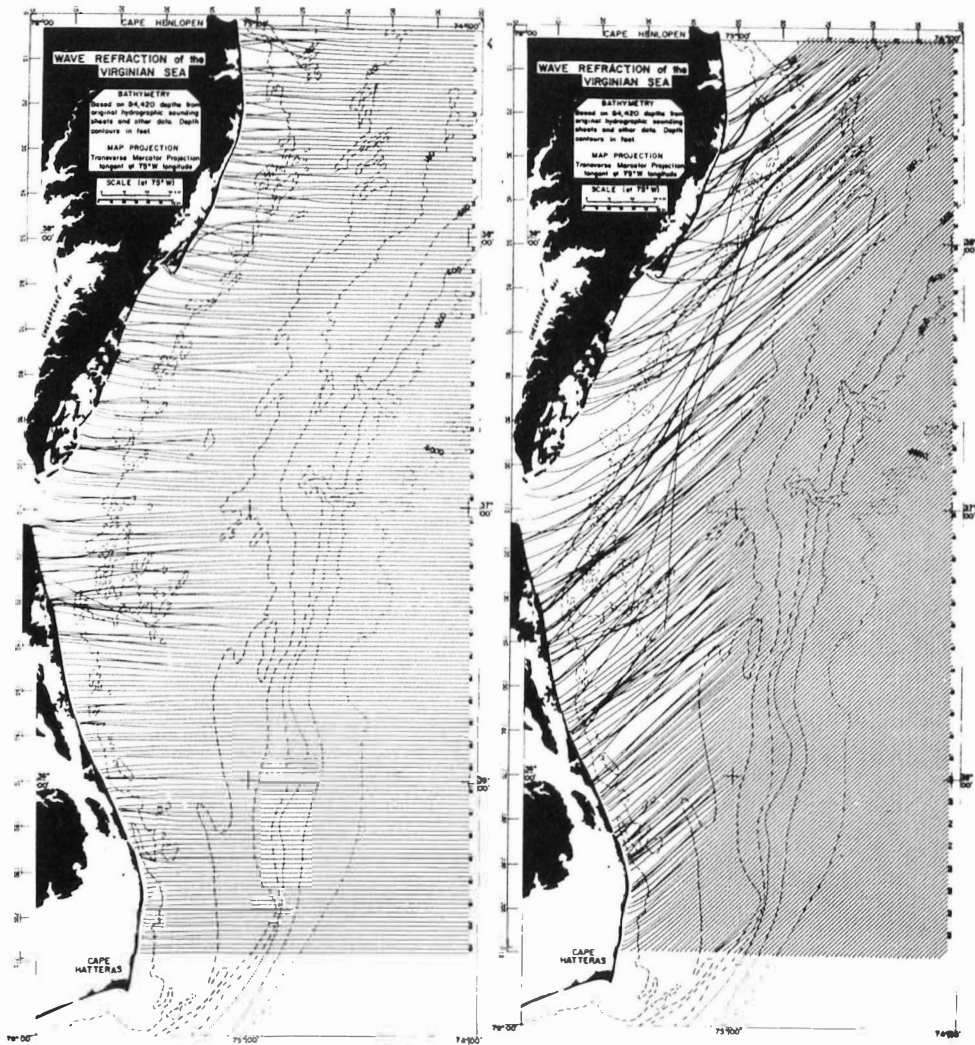


the Virginia continental shelf, covering an area over 20,000 square miles. The depth information will be displayed in the form of closely-spaced contoured maps which should provide very valuable information for any kind of study of the shelf, whether it be a physical, chemical or biological study. A large multicolored bathymetric map of this area of the continental shelf and upper slope is in the final stages of preparation. Contoured at 12-foot intervals out to 496 feet, and 100-foot intervals thereafter, this map will be made available to others.

In addition to the depth information, a wide variety of wave conditions was fed into the computer along with the wave refraction program. The large depth array and extensive list of output variables require a computer system able to handle space beyond the storage area of most facilities. The NASA-Langley Research Center provided four CDC 6400 computers, as well as considerable computer expertise. Their contribution to the study amounted to \$30,000 in computer time and two man-years. In addition to their facilities and manpower, NASA-Langley evidenced great interest in the study. Thus our work during 1972 represented a strong collaborative effort between VIMS and NASA-Langley.

One other important aspect of the studies during the report year was to adapt the wave refraction computer program to the VIMS IBM 360 computer capability. Usage of this additional computer facility will expedite the study of smaller grids involving specific problems, especially in "crisis" situations.

Two of the 126 wave conditions of the computed Virginian Sea Wave Climate Model are shown below. Waves are from the northeast (right) and the east (left) for wave periods equal to 8 seconds and wave height equal to 2 feet at low tide.



Inventory of Mineral Resources off Chesapeake Bay

More than 5,400 square kilometers of the inner continental shelf floor off Chesapeake Bay has been delineated as containing mineral resources favorable for mining. The area holds potentially important deposits of sand, gravel, shell and heavy minerals.

This study was designed to evaluate the sedimentary materials of the shelf floor as potential mineral resources. Specifically, where are concentrations of minerals located? What are the textural and

mineralogic properties, their concentration or grade? Certain geologic "controls" were developed to assist in extending the evaluations spatially and with depth.

The one-year effort consisted mainly of laboratory analyses of more than 300 samples collected on prior cruises. Grain size was determined with a Woods Hole Rapid Sand Analyzer and gravel was determined by sieving. Mineralogic composition of sand-



size material was accomplished under a binocular microscope and heavy mineral content was determined by heavy liquid separation as well as by petrographic examination. Results were compiled into a series of distributional charts showing the location, extent, composition and grade of surface sediments.

SAND

Sand is the largest and most immediately useful resource. If the surface distributions extend to an assumed dredging depth of three meters, then there is an estimated two billion tons of sand in the area. This is sufficient to meet future needs of the Chesapeake region for hundreds of years. The sand consists of two types: fine sand which is gray-colored, relatively clean, well-sorted and rich in quartz; and medium-to-course sand which is typically iron-stained, poorly sorted and contains 5 to 15% shell. The fine sand is distributed mainly as an apron along inner parts, 25 to 35 kilometers offshore, whereas the coarse sand covers outer parts and isolated ridges of inner parts.

GRAVEL

Gravel is distributed in isolated patches mainly along the 20 to 23 meter depth zone. It occurs either as a surficial lag deposit or as surface outcroppings of more extensive beds. Altogether, an estimated 143 square kilometers of gravel was charted. This includes substantial showings within 25 kilometers of the Chesapeake entrance that are relatively close to shelter for mining dredges and close to a major East Coast market.

HEAVY MINERALS

The heavy mineral fraction comprised between 0 and 20% by weight of the total sample, averaging $5.3 \pm 3.8\%$. Dominant heavy minerals were garnet, magnetite-ilmenite, hornblende and epidote. Less abundant were kyanite, sillimanite, andalusite, apatite, tourmaline, rutile and zircon. Combined percentages of economically important rutile, ilmenite and zircon locally are 1 to 1½%. Occasionally, phosphatic shell fragments dominate not only the heavy mineral suite but the total sample. In general, weight percent of the heavy mineral fraction varies inversely with the mean grain size. Garnet, hornblende and the opaques dominate the coarser fractions.

Distribution of the total heavy mineral assemblage indicated a concentration paralleling the coast in a zone between nine and 18 meters (30 to 60 feet). Enrichment in this zone is most likely produced by hydraulic fractionation of wave action. Heavy minerals are supplied to the area from the Chesapeake and Delaware as well as relic deposits on the shelf floor.

Results of this study contribute significantly to knowledge of resources in this portion of the mid-Atlantic Shelf. They enhance diagnostic and predictive capability to extend this new knowledge and should reinforce state and federal ability to design regulatory guidelines for wise management of the resources.



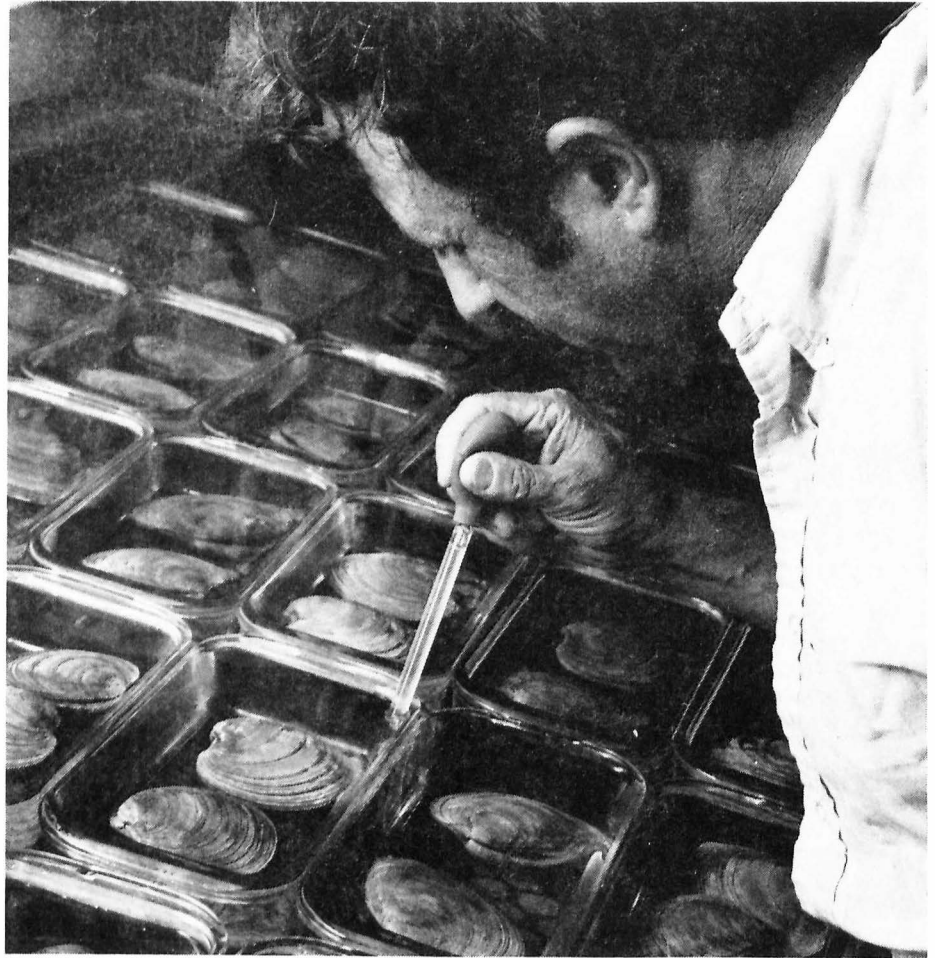
Improvement of Fisheries for Molluscs

Experiments to develop commercially applicable methods for growing clams and scallops from egg to market size were being conducted at the Wachapreague branch laboratory on Virginia's Eastern Shore. If the methods are

successful and feasible, the industry can be instructed in these methods and a new industry to supplement the wild harvesting can be developed.

During the report year, clams (*Mercenaria mercenaria*) again were cultured by the methods described by Loosanoff and Davis (1963).

To supply food, natural seawater



was clarified or filtered, then stored in 850-gallon tanks in a greenhouse for 24 to 36 hours to enhance the phytoplankton growth. This method was an inexpensive, efficient way to produce large amounts of mixed phytoplankton food. Although larval culture could be improved, this was not the problem area in molluscan culture, since even with the present methods we can set more molluscs than we can handle as juveniles. Until some of the more pressing problems of juvenile growing are solved, this method will serve adequately. Using the present method, we were able to set 203×10^6 clams, along with 18×10^6 of other species.

After clams leave the culture lab, they are held in flowing seawater for a few weeks and then planted in plots where gravel has been spread over the bottom. The use of gravel aggregate makes it possible for tiny clams to be grown on bottoms instead of in trays.

Some of the experimental plots gave phenomenal results; others were failures. Plantings in deeper water or areas protected from winds by a section of marsh did better than those in more exposed areas. Also, more clams were recovered on soft muddy bottoms than on sand or gravel bottoms. Since soft mud bottoms indicate a low current

velocity, we concluded that clams on sand or gravel bottoms are washed out by currents and lost.

Laboratory tests indicated that laminar flow current with velocities of 20 cm/sec will cause clams of 15 mm width to move. Sheer forces associated with wind-driven waves are far worse. This indicates that plantings of clams should be in protected areas, or the plots themselves should be provided protection such as current baffles or dampening devices. Experiments to test this approach were underway.

In addition to research, clams and information were furnished to other agencies and to private individuals interested in growing clams.

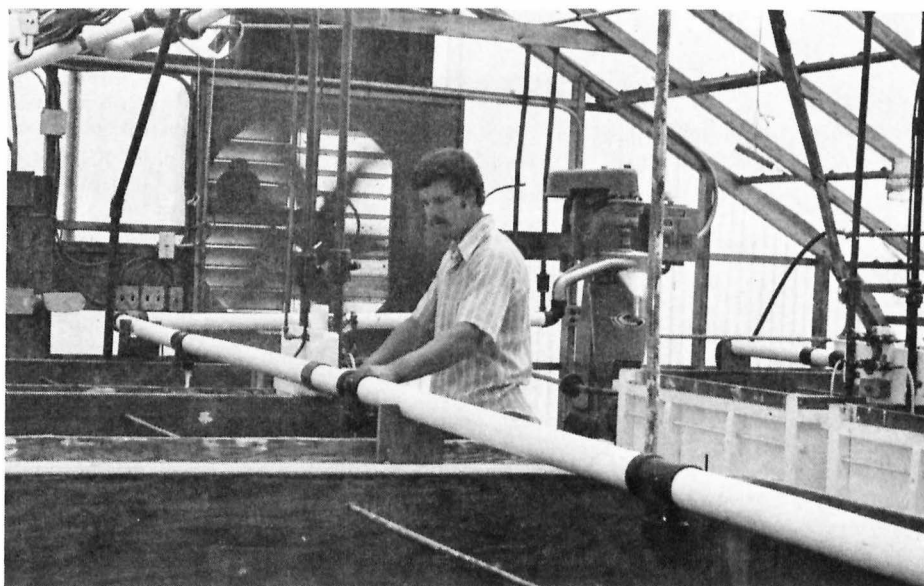
From our research on the scallop (*Argopecten irradians*), we concluded that scallops held directly on

the bottom in pens, naturally enclosed bodies of water, or in off-bottom trays would grow and survive better than if held in surface enclosures. An attempt to grow scallops in a naturally-enclosed body of water will be initiated in the summer of 1973. A large number of marked and unmarked scallops will be released in Bradford's Bay to test the survival, movement, growth and harvestability of this animal.

Cost estimates of the VIMS method of growing clams and of scallop culture were presented to Sea Grant.

LITERATURE CITED

LOOSANOFF, V. L. and H. G. DAVIS. 1963. Rearing of bivalve mollusks. *Advan. Mar. Biol.* 1:1-136.



Improvement of Fisheries for Crustaceans

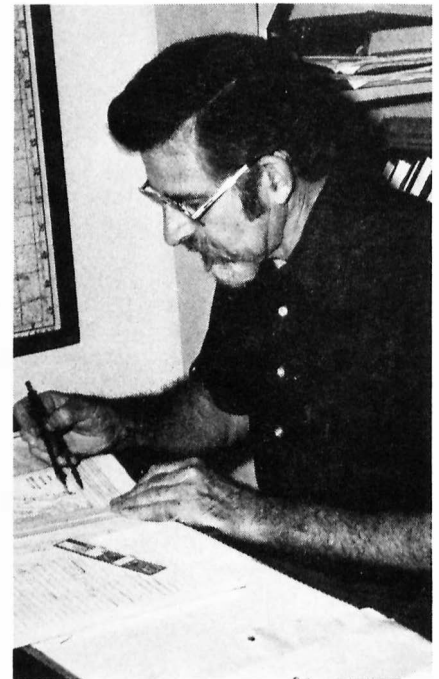
The long-term objectives of research conducted on crustaceans were: (1) To identify the physical, chemical and biological conditions necessary for increasing the commercial production of soft blue crabs (*Callinectes sapidus*); (2) To obtain data for future effective management and harvesting of hard blue crabs; (3) To determine the potential for commercial exploitation of the rock crab (*Cancer irroratus*); (4) To determine the effect of stress conditions on metabolism and survival of blue crabs.

SOFT BLUE CRABS

Primary effort in the soft blue crab subproject was to develop a recirculated water system for holding and shedding blue crabs. Emphasis was placed on long-term (29-33 day) experiments in which mixed stage peelers from the York River were added to the systems at regular intervals to maintain certain biomass levels. The systems used were designed to provide filtration and water treatment (ozone, protein skimmers, aeration) in a reservoir. A small ultraviolet lamp was used to treat the water flowing in a thin film over a fiberglass plate. Water flowed from the crab holding tank into the reservoir, and through granular dolomite filtrant supported by a false bottom of perforated fiberglass. The water was then air lifted back into the holding tank. Success, in terms of yield of soft

crabs, varied from 26 to 95%, and was directly dependent on the quantity of crabs (biomass density) in the shedding tanks. A biomass equivalent to 40 crabs/250 gallons of water per day produced a high soft crab yield (75% molt). These figures applied when salinity and temperature were 20-23‰ and 21-25 C, respectively. At higher temperatures, high yields were obtained only with smaller biomass loads. Biomass densities greater than 40 crabs per day were associated with increased mortality. Yields from an open-flow system were not appreciably different.

Low yields probably resulted

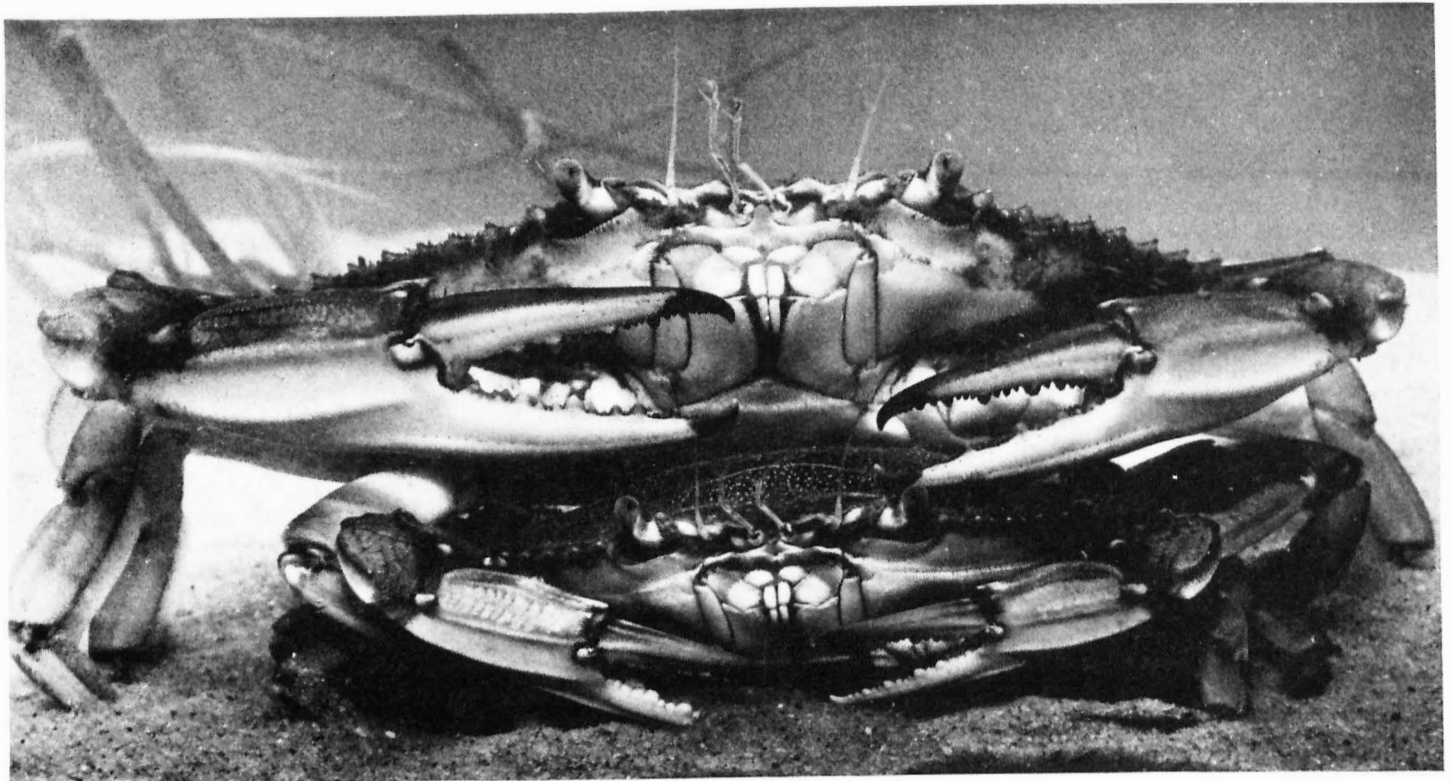


from an accumulation of toxic nitrogenous waste products. The filtration systems were capable of controlling ammonia, nitrite and nitrate at acceptable levels when the daily crab biomass did not exceed 40 crabs/250 gallons of water. Satisfactory waste-treatment has not yet been devised to permit loading the shedding tanks with more than about 10% of the crabs normally held in a commercial operation.

Results obtained in 1972 were superior to those found in 1970 and 1971. In those earlier years, yield

was highly variable and primarily dependent on water quality and the state of health of the crabs; biomass load was of little importance. In 1970, the recirculated seawater systems were admittedly archaic in their construction. Flow rate and filtration capacity were low and inadequate. Lowest returns were obtained in 1971 in spite of the fact that the recirculated seawater systems were upgraded to essentially the same as those used in 1972.

Many shedding houses found a high mortality among peelers in 1971. Crabs from our source of supply were infected with *Vibrio parahaemolyticus*, a bacterium endemic in Chesapeake Bay and known to have caused the death of peeler crabs in a commercial crab shedding house in 1968 (Krantz, Colwell and Lovelace, 1969; Colwell, 1972).



ROCK CRABS

Studies of the distribution, abundance and general biology of the rock crab in Chesapeake Bay and in coastal waters off Chincoteague, Virginia, near Blackfish Bank, were completed by two graduate students during the report year. Their research which was based primarily on sampling from commercial dredges and pots and by experimental trawling, was completed and their theses were being written during the report period.

The potential for a hard rock crab fishery in the Bay and nearshore waters of the shelf appears limited. Hard crabs occur from June through December or January, but are abundant in the bay only during December. From February through April, crabs are abundant in the Bay and offshore to 12 miles, but most are papershells and have poor meat yield. Rock crab abundance farther offshore (up to 18.6 miles) was relatively unknown, but appeared to be light; most crabs are hard from April through September.

A potentially valuable fishery for soft rock crabs exists in Chesapeake Bay. Most crabs caught in late December and January are peelers. Shedding occurs primarily in January, apparently related to, or triggered by minimum water temperatures. The abundance of papershells in April indicates that hardening of the shell takes two or more months in the natural environment.



SOFT ROCK CRABS

The potential for producing soft rock crabs from peeler crabs captured in the winter dredge fishery was explored in the laboratory during the winters of 1971-72 and 1972-73. Shedding seasons were short both years (most crabs shed in January and only a few shed in late December and early February). A few commercial blue crab shedding houses, normally closed in winter, produced a small number of soft rock crabs. Production was limited by number of crabs obtained for shedding.

Stages of the shedding cycle were identified by changes in shell rigidity of the rock crab. In the hard crab, the sub-branchial area above leg bases is firm. In peeler stages, the epimeral suture of the subbranchial shell is flexible under light finger pressure but cracks just before the crab sheds. Later, in papershell stages, the shell is first leathery and pliable to the touch, and then brittle.

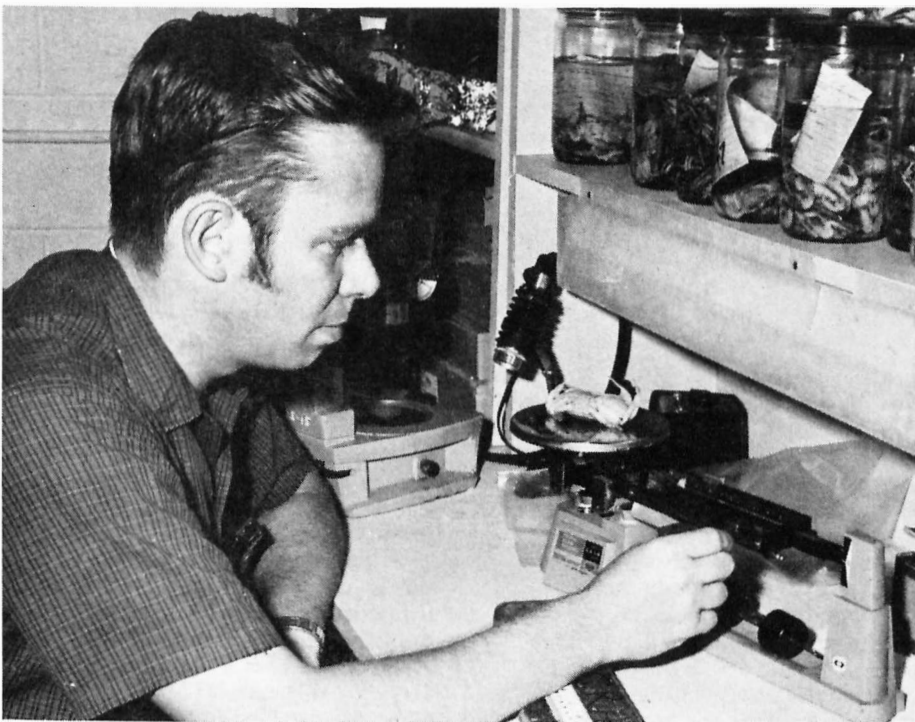
Several other signs confirm the identity of the shedding stages. Development of the new shell in the peeler is visible in borders of the

maxillae and maxillipeds, but no color signs are detectable. When the tips of legs and the movable finger of the claw of a peeler crab are broken or dislocated, the new shell is seen. In the hard crab, breakage of legs causes bleeding.

Shedding success in the laboratory depended on crab size. Among crabs 50 to 80 mm wide (2 to 3.2 inches), more than 50% shed; however, no crab over 100 mm (4 inches) shed. Holding time before shedding and time to reach mid-papershell stage depended on temperature. Crabs shed in nine days and became mid-term papershells (brittle shells) three days later when held at 17.5 C (64F). Crabs held at 7 C (45F) shed in 27 days and became mid-papershells 15 days later. However, in temperature-salinity tolerance studies, more crabs survived at 7 C than at 17.5 C, and also in 14 to 21‰ salinity rather than at lower or higher salinities. Papershell crabs were hardier than peelers, while hard crabs were usually the least tolerant of extreme salinities.

Weight increase was over 50%, and width increment averaged 20% when the crab shed. The increase in weight was essentially an increase in water content. Average water content was about 67% of the total weight before the crab shed and about 87% after shedding.

A manuscript on "Aspects of molting of male Chesapeake Bay rock crabs" has been written by Dr. Paul A. Haefner, Jr., and is being revised for publication. "Methods for shedding rock crabs in winter" were described in the *Marine Resource Information Bulletin*, Vol. 4, No. 15, November 28, 1972.

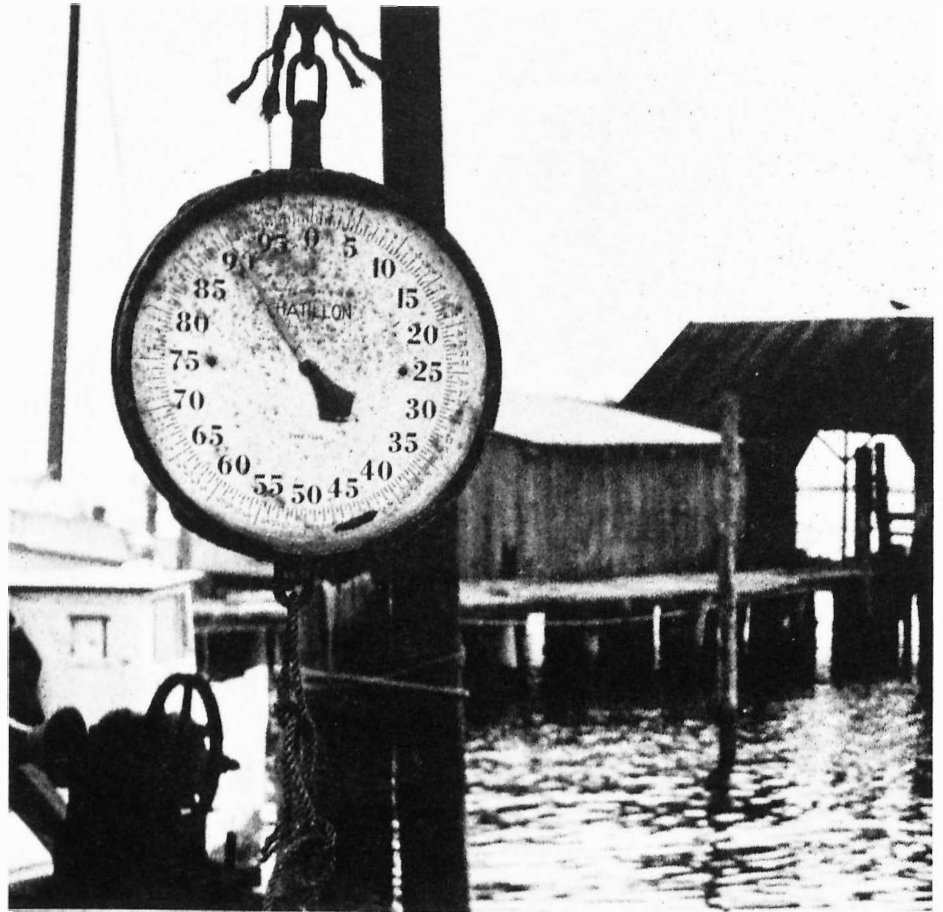


BLUE CRABS

Commercial landings of the blue crab from Virginia and Maryland in 1972 were slightly less than the recent 11-year average of 76 M pounds, exactly as predicted 12 months earlier. Yearclasses 1970 and 1971 made up the annual catch but did not provide equal shares. Yearclass 1970, which provided almost 51 M pounds from January through August 1972, was the largest yearclass since 1965. By contrast, yearclass 1971 appears to be one of the weakest in the last 11 years. It contributed only 21 M pounds, 80% of average catch in the last four months of the year. The potential catch for the first seven months following the close of the report period, derived from the weak 1971 yearclass, was estimated lower than at any time since 1960.

The potential catch for the year beginning September 1973 was expected to be below average. Fear that Tropical Storm Agnes and the aftermath of depressed salinities throughout the lower bay had prevented spawning, or had killed many larvae in the summer of 1972, seemed verified by a small catch of young crabs from September through December 1972. Since the close of the report period, exceptionally large numbers of young crabs, presumably hatched very late in 1972, have been caught and it is now expected that the potential catch will be above average. The reversal of the prediction justified its inclusion in this report.

A description of the winter dredge fishery of December 1970 through March 1971 was nearing



completion at the end of the report period. Study of the fishery was undertaken to estimate total catch, population size and fishing mortality. It will also serve as a pilot project to provide a model and experience for determining the effects of other types of fishing gear on blue crab stocks. Evidence is presented in the report that parent stock size accounts for little of the

variation in progeny stock size, and that presently there is no evidence that blue crabs are being overfished in the Chesapeake Bay.

A paper on "The effect of a tickler chain and tow duration on trawl catches of the blue crab" was published in the Transactions of the American Fisheries Society, Vol. 101, No. 4, pages 732-734 as VIMS Contribution No. 445.

PHYSIOLOGICAL STUDIES

A study of oxygen consumption of the blue crab was completed by a graduate student during the year. Primary objective was to examine the effects of several factors, such as sex, weight, acclimation temperature, acclimation salinity, acute temperature changes and acute salinity changes. Of secondary interest were the effects of the stages of the molt cycle, injury and desiccation on oxygen consumption, the behavioral manifestation of hypoxia and gill ventilation rates. A thesis was being prepared on the subject at the close of the report period.

The use of serum constituents as indicators of physiological stress was the objective of another graduate student study. Chloride, protein, glucose, ninhydrin positive substances (NPS) and osmotic concentration of blue crabs subjected to various stresses were compared with the baseline concentration of the same constituents from natural environments. Glucose in new yearclass females and protein in males and females were significantly higher in red tide stressed crabs than in unstressed crabs. Protein and osmotic concentration were significantly lower in DDT stressed males. Higher NPS, osmotic concentration and glucose and lower chloride were found in females experiencing thermal stress. Holding crabs in aquaria resulted in short-term glucose elevations and lower osmotic concentration, protein and NPS. The results of the study were presented at a meeting

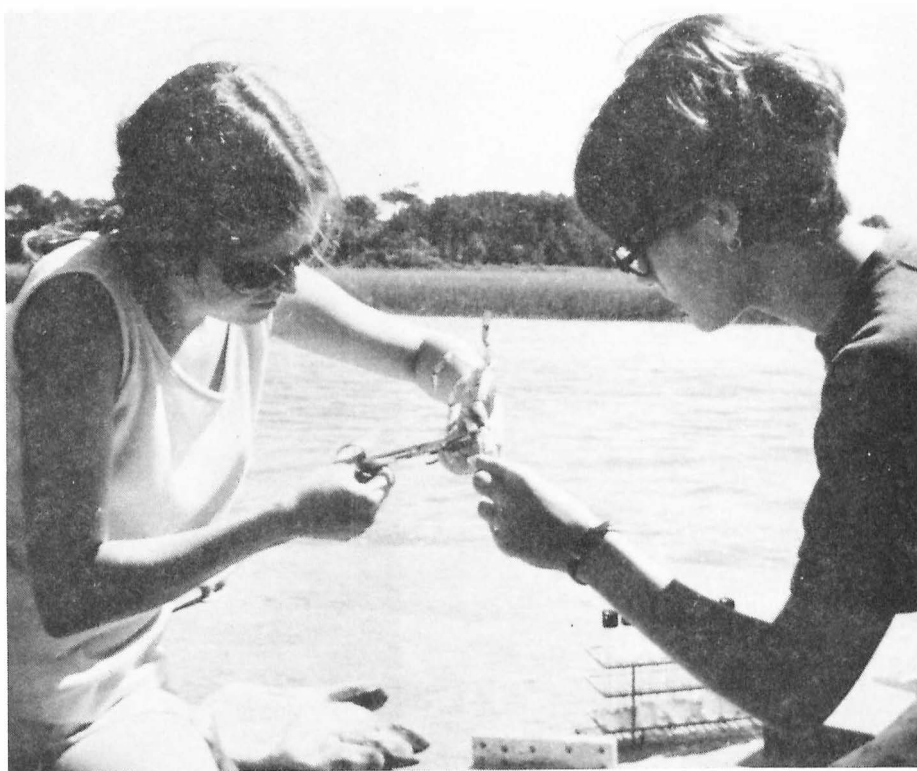
of the Virginia Academy of Sciences. An abstract appeared in the Virginia Journal of Science, Vol. 23, No. 3, page 113 (1972).

Two scientific articles on larval stages of two species of crab written with partial support of Sea Grant under the Improvement of Fisheries for Crustaceans Program, were published during the year. These appeared in 1972 in *Crustaceana*,

Vol. 23, No. 2, pages 141-151 and the Journal of the Elisha Mitchell Scientific Society, Vol. 88, No. 4, pages 220-225 as VIMS Contributions 445 and 405, respectively.

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Management of Larvae— Supply of Algal Food

As in the first three years, most effort was devoted to the development of techniques that can be utilized by hatcheries designed to efficiently produce large quantities of seed oysters.

Previously-developed methods for conditioning and spawning local oyster stock (James River, York River, Rappahannock River, Mobjack Bay and Potomac River) continue to demonstrate a year-round reliability in obtaining oyster larvae. Methods to produce cultch-free spat obtained by setting on artificial cultch, and then removing them,

have demonstrated success in obtaining large quantities of free spat for distribution to other projects and future distribution to local industry. (A publication, "The Development of Laboratory Techniques for the Production of Cultch-Free Spat of the Oyster *Crassostrea virginica*", Chesapeake Science, Vol. 13, No. 1, p. 45-52, is available.) In addition, with the utilization of thermal energy during the months of November, December, January and February, growth of newly-set spat to a commercial-size oyster in one year was demonstrated



on a small scale in our specially-designed flumes.

During the past year, as in the year before, approximately 5,500 gallons of unialgal food was produced from five-gallon mass cultures for feeding various species of bivalves and their larvae. However, a greater variety of species have been put into mass culture this year.

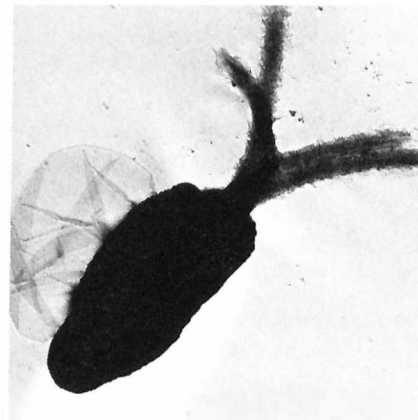
The new algal species (Va 17 and Va 12), previously reported as enhancing oyster larval growth in combination with *Monochrysis lutheri* and *Isochrysis galbana*, continued to promote setting in 11 to 14 days on a year-round basis. The use of *Monochrysis lutheri* and *Isochrysis galbana* alone, with few exceptions, promoted setting in 19 to 25 days. Another Chrysophyte (Va 20) has shown promise; however, recent tests indicate that it

has an inhibitory effect on the growth of larvae when utilized as a food during the first five days of the larval period. Preliminary results show that Va 20, like Va 12, may enhance the growth of oyster larvae past the 150 μ size.

New isolates, Va 20, Va 33, Va 34 and Va 36, are yet to be tested as to their potential for a larval food, and we are in the process of isolating four to six other nanoplankton species found in abundance during the spring and summer seasons.

Approximately 25,000 one-half-inch free spat, consisting of 14 genetic groups, were delivered to the VIMS Malacology Department through June of 1972 for use in experiments aimed at development of disease-resistant oysters. Of the eleven groups produced in 1971, one group of oysters (P 86) exhibited marked cupping and very rapid growth. Varying environmental conditions did not appear to affect their growth patterns. This group was spawned and larvae was reared to setting again in the fall of 1972 to ascertain whether the phenotype is a genetic marker. The deep cupping of the left valve and the relatively flat shape of the right valve, when combined with a rapidly growing oyster (market size in 11 months), can provide an oyster which will yield a greater weight and volume of meat for its unit size.

Approximately 150,000 cultch free oysters (10-20 mm) were produced in the fall of 1972 from experimental bio-assay to use as a test group in a hatchery that was developed and built with our advice by a seafood producing firm located at Colonial Beach, Virginia.



Sea Grant Publications

- Burrell, V. G., Mike Castagna and Robert K. Dias, editors. 1972. A study of the commercial and recreational fisheries of the Eastern Shore of Virginia, Accomack and Northampton Counties. VIMS Special Report No. 20.
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Sea Grant Activity Budget—1972

	NOAA Grant Funds	VIMS Matching Funds	Totals
<i>Marine Resources Development</i>			
Aquaculture-Molluscs	\$ 35,000	\$18,791	\$ 53,791
Commercial Fisheries-Biology	120,750	68,838	189,588
Geological Oceanography	17,560	8,780	26,340
<i>Marine Environmental Research</i>			
Coastal Zone Management- Natural Sciences and Engineering	29,400	14,724	44,124
<i>Advisory Services</i>			
Extension Programs, Publications and Other Advisory Services	91,810	48,454	140,264
<i>Program Management and Development</i>			
Program Administration	<u>30,480</u>	<u>15,076</u>	<u>45,556</u>
Totals	\$325,000	\$174,663	\$499,663

